U.S. Army Research, Development and Engineering Command

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

MATREX - Modeling Architecture for Technology, Research and EXperimentation

Presentation to DoD M&S Conference 2008 Tutorial

Tom Hurt, MATREX PM

10 March 2008

Tom Hurt / 703.806.0995 / tom.hurt@us.army.mil

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
10 MAR 2008	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
MATREX - Modeling Architecture for Technology, Research and EXperimentation	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Research, Development and Engineering Command**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

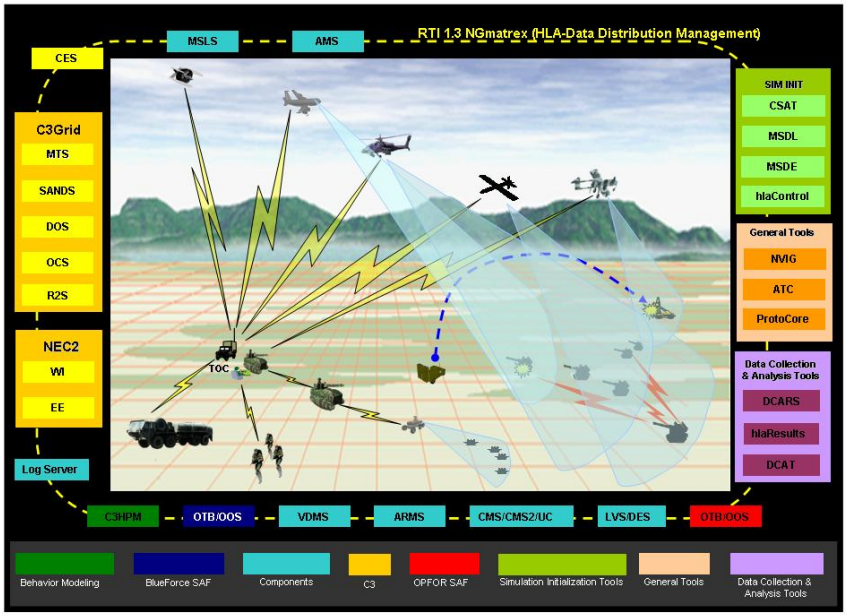
13. SUPPLEMENTARY NOTES
2008 DoD M&S (Modeling and Simulation) Conference Presentations held in Orlando, Florida on March 10 - 14, 2008, The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**15**	

MATREX Purpose



Primary Partners and Customers:

- RDECOM HQ, RDECs, and Labs
- PM FCS (BCT) MSO / FCS LSI
- TRADOC (BLCSE)
- ATEC (OTC)
- 3CE (Cross Command Collaboration Effort)
- Other Army PMs and PEOs

Purpose:

To develop a composable Battle Command-centric M&S environment consisting of multi-fidelity models, simulations and tools that are integrated and mapped to a Future Force/Blended Force architecture for use across the acquisition spectrum

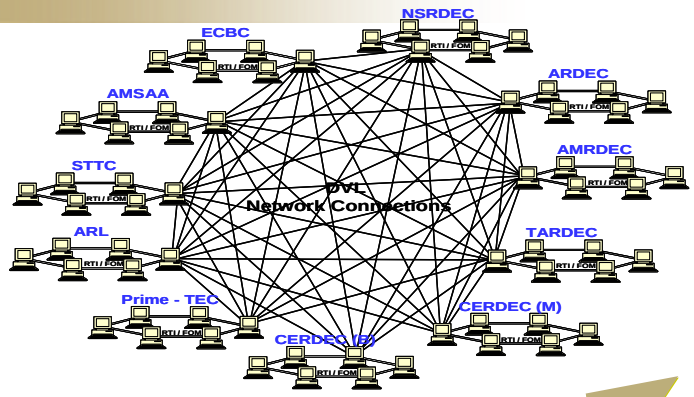
Benefits:

- Enables interoperability across commands, PEOs/PMs, and Joint for:
  - Engineering model development and evaluation
  - Technology tradeoffs
  - Capabilities assessments
  - Concept development
  - Experimentation
  - Testing
  - Training
- Mutually and collectively leverages the world-class expertise of all RDECOM M&S laboratories for the benefit of the Army, and Joint
- Supports decision making over entire acquisition cycle

Critical M&S capabilities necessary to support Battle Command representation and analysis

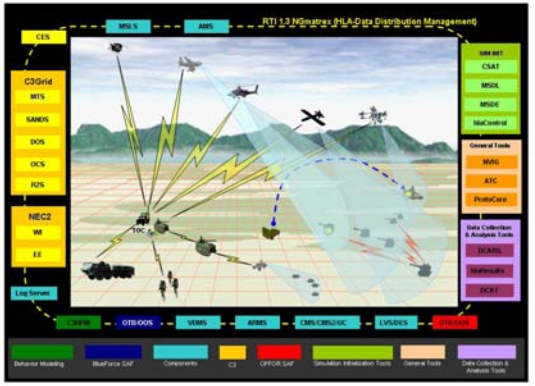
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

The MATREX Paradigm



MATREX M&S Environment

- Service-Oriented Architecture
- Entity-level COP, distributed SA, with NCW emphasis
- Supports FCS LSI, 3CE, BLCSE, USAOTC, & more



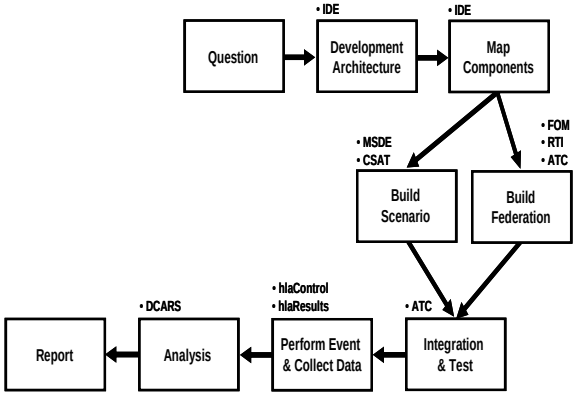
Distributed Virtual Laboratory

- Network hardware Infrastructure
- Interconnect RDECOM M&S activities
- Connect to 3CE Network (TRADOC BLCSE, ATEC ATIN, FCS LSI)

Robust M&S capabilities from requirements development through integration and test

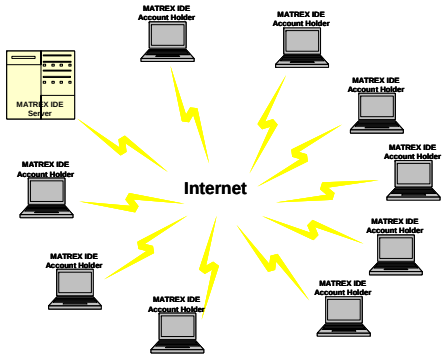
Integrated Development Environment

- Distributed Systems Engineering
- Requirements and architecture map all the way to the FOM
- Processes and tools
- Collaboration within M&S development and user community



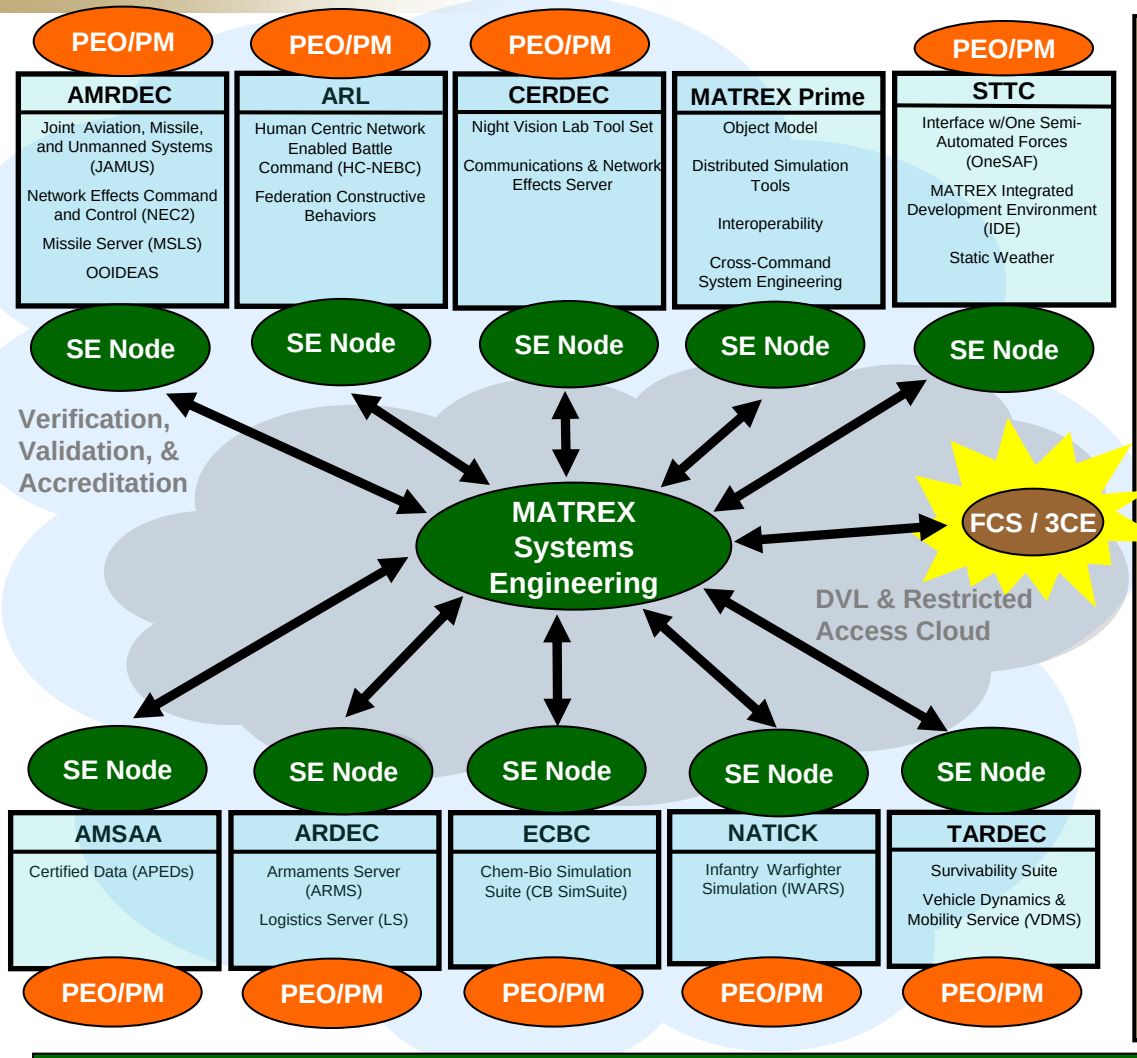
M&S Event Management

- Foundation for Army M&S events
- Functional system design
- Software integration and test tools
- simulation middleware
- object model
- event execution services



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Systems Engineering for MATREX and RDECOM - Operational View



Integrated M&S System of Systems Engineering (SE) Capability for RDECOM via MATREX:

- **Supporting PEOs and PMs with a coordinated and uniform RDECOM approach**
- **Common integrating SoS Architecture synchronized across RDECOM**
- **Developing SE Nodes for M&S across RDECOM:**
  - Single integrated M&S culture
  - In-Common engineering tools
  - Common requirements database, terminology, and processes
  - Distributed and Collaborative enabling services:
    - Web Collaboration (STEM, IDE, AKO)
    - DVL Services
- **Maximize interoperability, flexibility and adaptation of RDECOM M&S capabilities to the Acquisition Communities needs.**
- **Common OM and Core Capabilities/Tools**

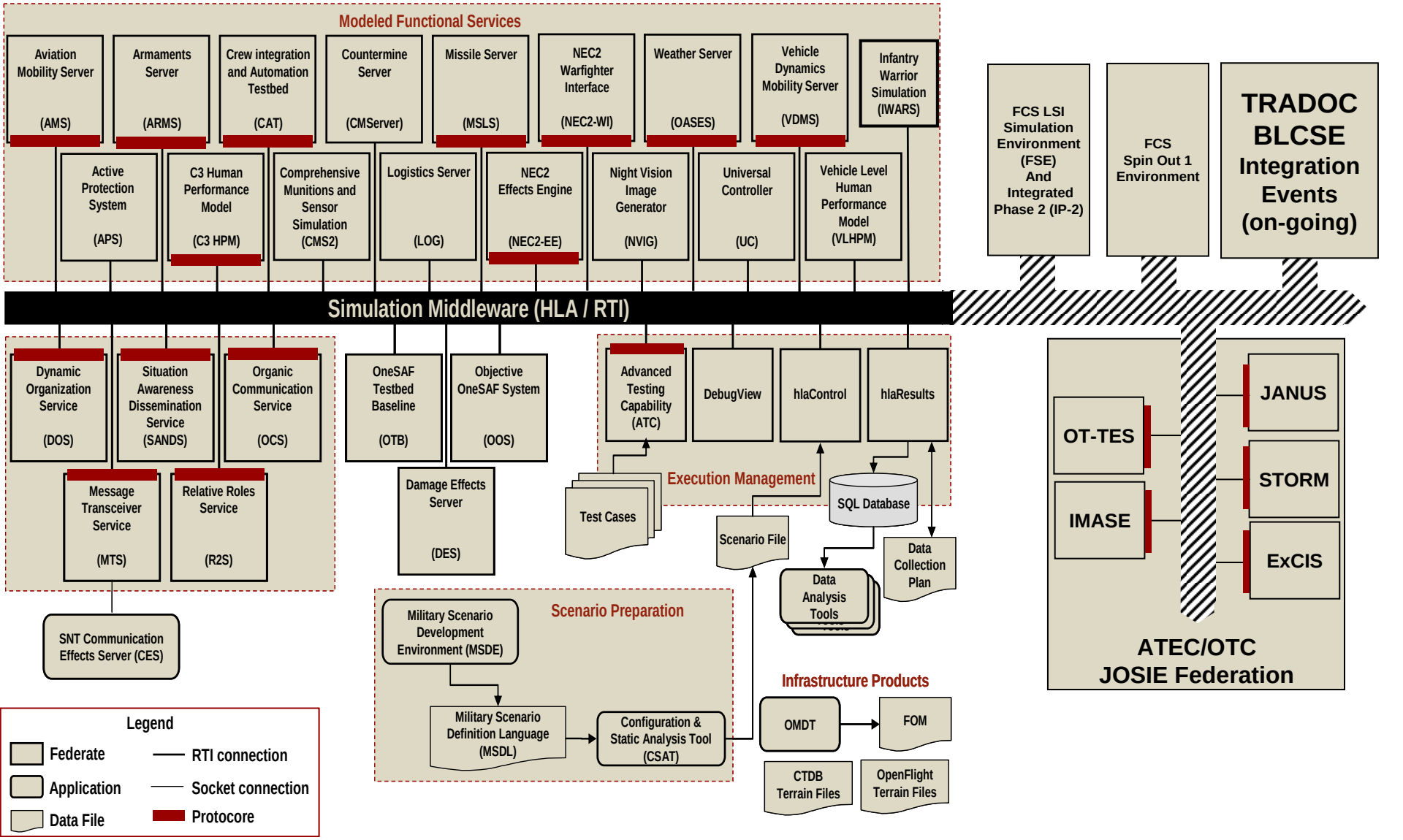
MATREX reduces Technical and Cost Risks for the FCS and other programs through external coordination of RDECOM M&S

MATREX Tools Enable a Common Integrated Architecture

Lowers the barrier to entry for utilization of MATREX High-Level Architecture (HLA) and widely used ATEC, RDECOM, and TRADOC M&S and tools

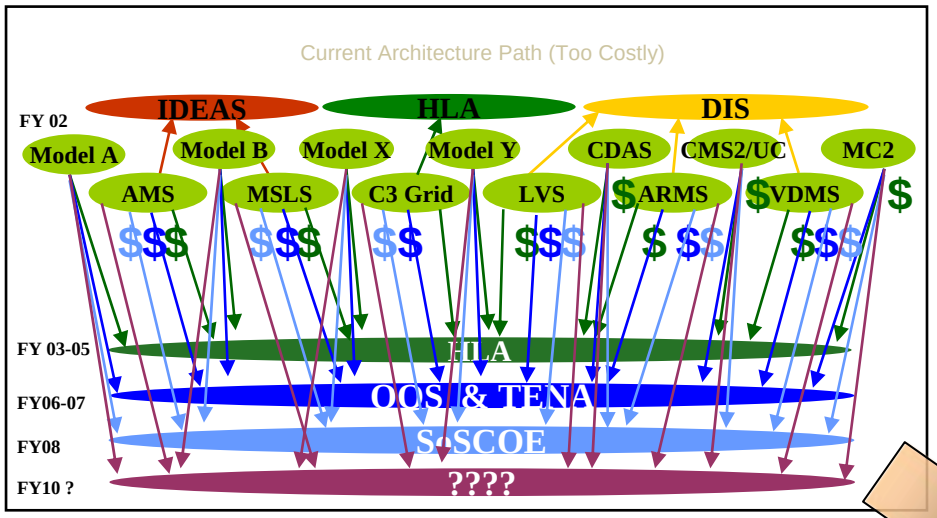
ProtoCore 1. M&S interoperability without gateways 2. Provided as GFX by MATREX with support & training available 3. Interoperability includes HLA RTI 1.3NGmatrex, IEEE 1516, (TENA 5.4 and DIS FY08)	**Integrated Development Environment (IDE)** 1. MATREX distributed engineering and communication capability over Internet 2. Linked and mapped content mgt system for rqts, design, (code) 3. Program Configuration Management mechanism
Federation Object Model (FOM) 1. In-common data structures, operations, and comms between federates 2. Describes which HLA services are used, how they are used, and how they are tied to events. 3. Co-managed with FCS LSI, provide basis for commonality in FCS M&S community and elsewhere	**Advanced Testing Capability (ATC)** 1. Unit, integration, and federation-level testing of M&S applications 2. Automated test case development, mapped to requirements 3. Provided as GFX by MATREX with support & training available 4. RTI and OM agile, simple test cases to vignettes (HLA, 1516, or TENA) 5. Enables executable architecture
Battle Command Interoperability Services (BCIS) 1. Supports entity-level communications and SA dissemination for Battle Command 2. Interconnects comms effects, sensor fusion, human behavior, network, human decision-making, OneSAF (OF OOS v1.5.1), High-Fidelity M&S 3. MTS, OCS, DOS, SANDS, R2S	**CSAT** 1. With OneSAF MSDE, complete scenario development process & tool set 2. Helps with remote creation of federates and force structure laydown. 3. Provided as GFX by MATREX with support & training available for both MSDE and CSAT 4. DCARS, Starship, Stargen, Systems Engineering
Distributed Virtual Lab (DVL) network 1. Interconnects RDECOM M&S users/developers via DREN 2. Connected to ATEC, TRADOC, and FCS LSI 3. Maintained by MATREX and the Centers/Labs	**Run-Time Infrastructure (RTI)** 1. Enables M&S interoperation over a network, including distributed 2. Embedded functionally to support entity-level analysis 3. Provided as GFX by MATREX, supported by MATREX

MATREX Building Common Cross-Army Environment



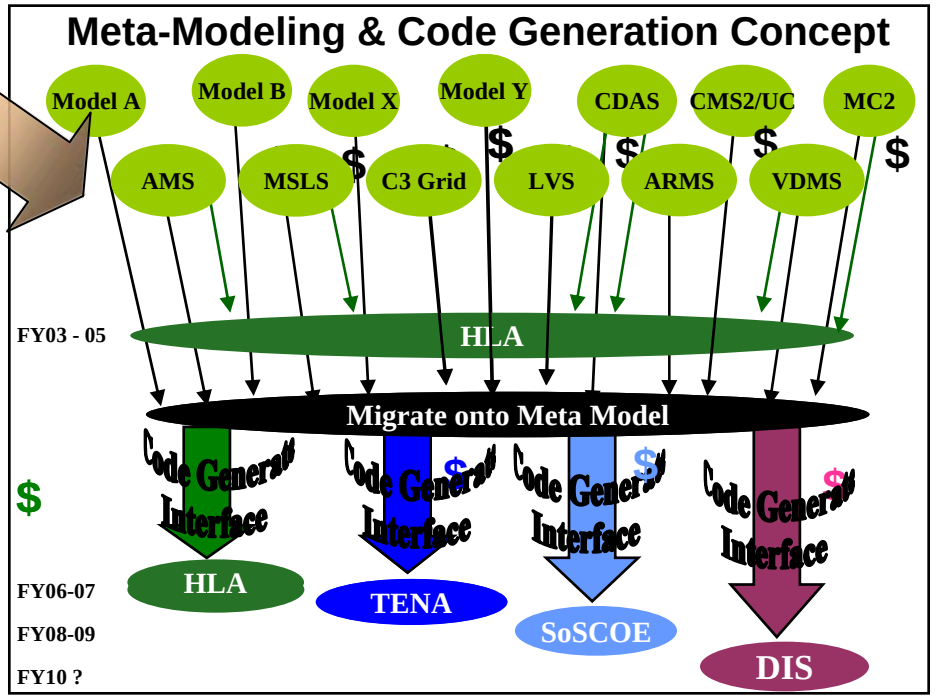
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

MATREX Enables M&S Seamless Interoperability



M&S Interoperability Problem Space

- The Army spends millions of dollars per year migrating Models and Simulations between various protocols and building gateways
- The average rate of change migrating from one protocol to the next is increasing



Results

- In use at RDECOM M&S activities
- In use at OTC with JOSIE+1 federation
- In use at FCS LSI at Huntington Beach FSE
- In use at Spin Out 1 events
- Planned for Stryker and other PMs in CY 2008
- Demonstrated at 2006 and 2008 DoD M&S Conference

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

MATREX Collaborations

Distributed to . . . .

TRADOC	Mounted Maneuver Battle Lab Air Maneuver Battle Lab Depth & Simultaneous Attack BL Battle Command Battle Lab TRAC Leavenworth TRAC-WSMR
ATEC	IRCC WSMAR HQ USAOTC USAOTC-IEW Electronic PG, Fort Lewis APG Test Center WDTC, Dugway PG RTTC RTTC-RSA
PM	PEO-STRI NLOS-LS PM C4ISR On-The-Move PM FCS (BCT) – FCS LSI PEO Soldier
Other Services	LMC-Orlando (USN) Navy Research Lab Naval Air Warfare Center JTAGGS (USAF)

Partners & Collaboration

ATEC (OTC/DTC)
- Test Event Support
- Live Interface
- Sim to C2
- Sim Research

TRADOC
- Analytical Requirements
- BLCSE Conversion to HLA
- FFID Planning
- Sim Infrastructure & Tools

3CE
- Core Planning
- Sim Systems Engineering
- Federation/FOM/Tools
- FCS Spin Out 1
- Sim Infrastructure & Tools

FCS LSI
- FOM
- FCS Simulation Environment (FSE) Collaboration & Development
- GFX Delivery, Training & Support

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Path Forward

- MATREX is building the Battle Command-centric M&S architecture mapped to OSD, TRADOC, and FCS requirements
- MATREX (RDECOM) is working with TRADOC, ATEC, PM FCS(BCT)/FCS LSI, and 3CE to build an Army solution for M&S experimentation applicable across the acquisition life cycle.
- MATREX is providing M&S capabilities to PMs to help reduce technical, cost, and schedule risk.

Tutorial Presentations on MATREX Simulation Architecture and Tools follow this brief.

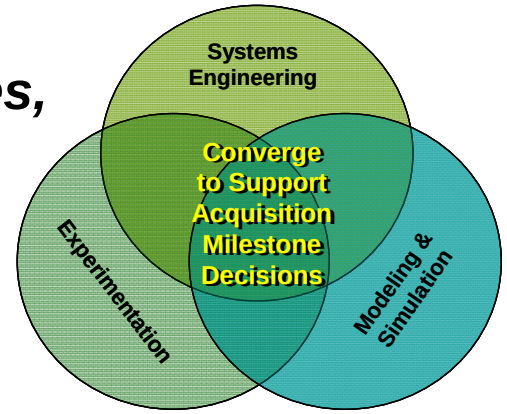
Acronyms

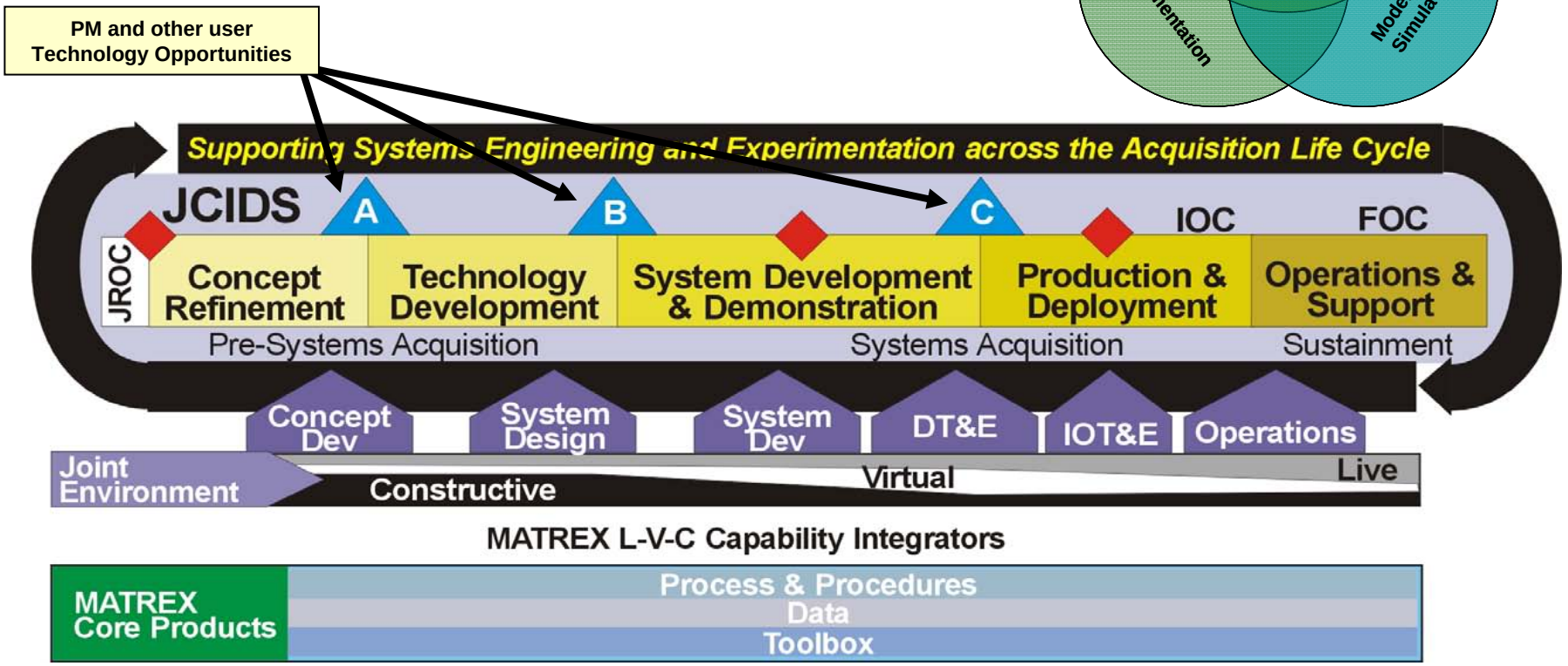
- 3CE – Cross-Command Collaborative Effort
- ACS – Aerial Common Sensor
- AKO – Army Knowledge On-Line
- ALCES - Aggregate Level Communications Effects Service
- AMS – Aviation Mobility Service
- AMSWG – (OSD) Acquisition Modeling & Simulation Working Group
- ARMS – Armaments Service
- ATC – Automated Test Capability
- ATEC – Army Test and Evaluation Command
- ATIN – ATEC Test Integration Network
- AUTL – Army Universal Task List
- BCT – Brigade Combat Team
- BLCSE – Battle Lab Collaborative Simulation Environment
- C3HPM – Command, Control, & Communications Human Performance Model
- C3GRID – Command & Control, Computer GRID
- CES – Communications Effects Server
- CMS – Countermine Server
- CMS2 – Comprehensive Munitions & Sensor Server
- CSAT – C4ISR Static Analysis Tool
- C4ISR – Command & Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
- DCARS – Digital Collection, Analysis & Reporting System
- DCA – Data Collection & Analysis
- DCAT – Data Collection & Analysis Tool
- DES – Damage Effects Server
- DOTMLPF – Doctrine, Organization, Training, Materiel, Leadership, Personnel & Facilities
- DOS – Dynamic Organization Service
- DTC – Developmental Test Command
- DTE – Distributed Test Event
- DT&E – Developmental Test and Evaluation
- DVL – Distributed Virtual Laboratory
- EE – Effects Engine
- FCS – Future Combat Systems
- FOC – Full Operational Capability
- FOM – Federation Object Model
- FRP – Full Rate Production
- FSE – FCS Simulation Environment
- HLA - RTI – High Level Architecture – Run Time Interface
- HC-NEBC – Human Centric – Network Enabled Battle Command
- HPM – Human Performance Model
- IDE – Integrated Development Environment
- IOC – Initial Operational Capability
- IOT&E – Initial Operational Test and Evaluation
- IER – Information Exchange Requirement
- IP03 – Integrated Process 03, Networked Fires
- IPT – Integrated Process Team
- IWARS/DI – Infantry Warrior Simulation/Dismounted Infantry
- JCAS – Joint Close Air Support
- JCIDS – Joint Combat Integrated Defense System
- JROC – Joint Requirements Oversight Council
- JSBE – Joint Service Battlespace Environment
- KPP – Key Performance Parameters
- LSI – Lead Systems Integrator (FCS)
- LVC – Live Virtual Constructive
- LVCI - Live Virtual Constructive Interoperability
- LVS – Lethality/Vulnerability Service
- MATREX – Modeling Architecture for Technology, Research, & EXperimentation
- MC2 – Mobile Command & Control
- MDA – Model Driven Architecture
- MMIC – MATREX Middleware Independence Capability
- MOE – Measures of Effectiveness
- MOP – Measures of Performance
- M&S – Modeling and Simulation
- MSDE – Military Scenario Development Environment
- MSDL – Military Scenario Definition Language
- MSLS – Missile Service
- MSO – PM FCS (BCT) Modeling & Simulation Office
- MTS – Message Transceiver Service NCW – Network Centric Warfare
- NEC2 – Networked Effects Command & Control
- NVIG – Night Vision Image Generator
- OCS – Organic Communications Service
- OneSAF – One Semi-Automated Forces
- OOS – OneSAF Objective System
- OTB – OneSAF Testbed Baseline
- OTC – Operational Test Command
- PEO – Program Executive Office
- PM – Product, or Program or Project Manager
- R2S – Relative Roles Server
- RDECOM – Research, Development, & Engineering Command
- RDEC – Research, Development & Engineering Center
- S3E – Systems Engineering, Experimentation, and Enterprise
- SANDS – Situational Awareness Normalization & Dissemination Service
- SE – Systems Engineering
- Sim Init – Simulation Initialization
- SNE – Synthetic Natural Environment
- SoS – System of System
- SoSE – System of System Engineering
- SOSCOE – System of Systems Common Operating Environment
- STEM – Science and Technology Enterprise Management
- S&T – Science and Technology
- TENA – Test & Training Enabling Architecture
- TIE – Technical Integration Event
- TRADOC – Training & Doctrine Command
- UAV – Unmanned Aerial Vehicle
- UC – Universal Controller
- UJTL – Universal Joint Task List
- USAF – United States Air Force
- USMC – United States Marine Corps
- VDMS – Vehicle Dynamics & Mobility Service
- V&V – Verification and Validation
- VV&A – Verification, Validation & Accreditation
- WECM – Warfighter Electronic Collection and Mapping
- WI – Warfighter Interface

BACK-UP SLIDES

MATREX Supports Entire Acquisition Life Cycle

Enable cross-commodity M&S tools, capabilities, processes and people to support technology development, systems integration and product development across the acquisition life cycle.





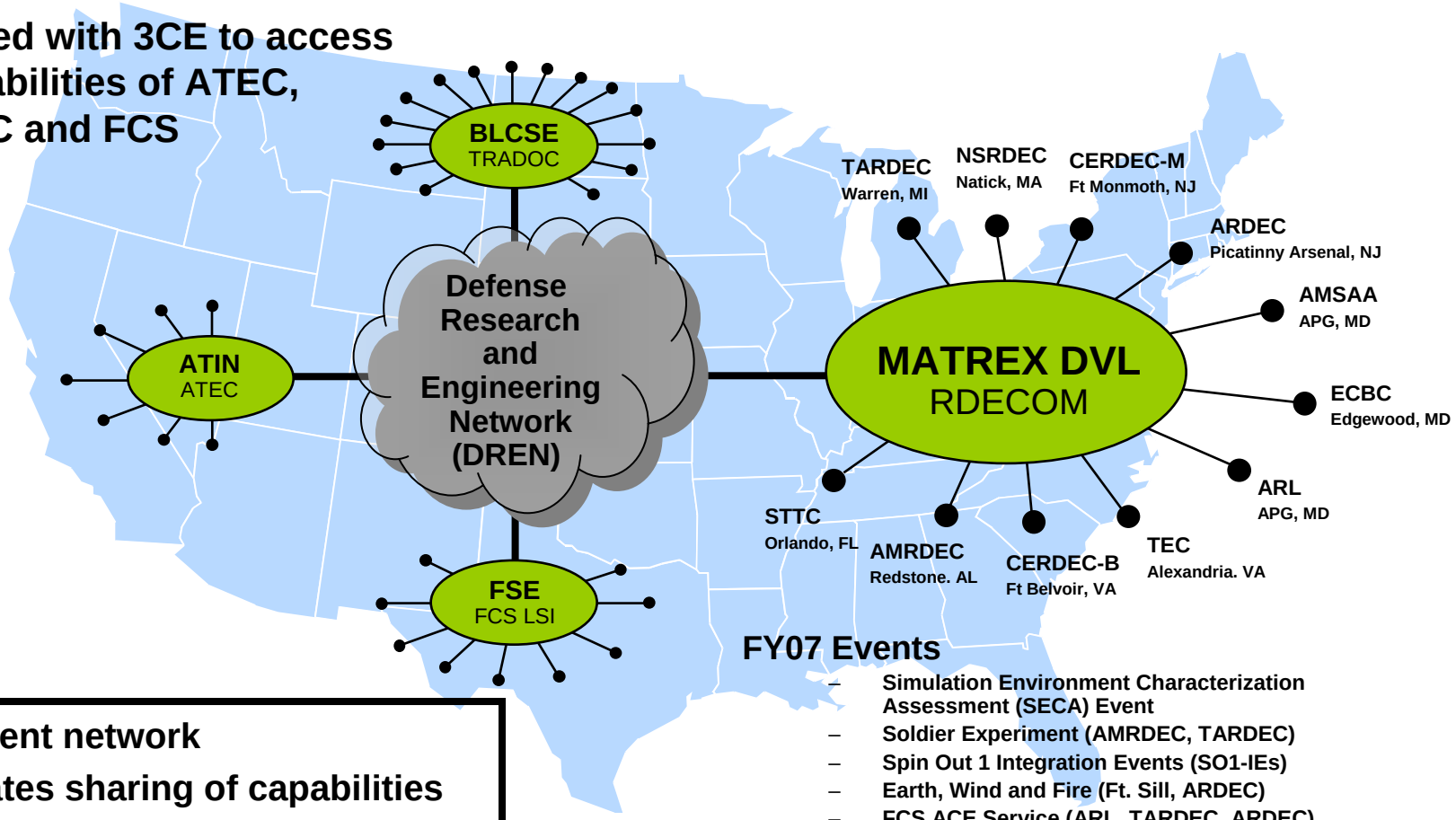
Reduce expense of “Live” activities

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

The MATREX Paradigm Distributed Execution

To Be Connected ------

Integrated with 3CE to access the capabilities of ATEC, TRADOC and FCS



FY07 Events

- Simulation Environment Characterization Assessment (SECA) Event
- Soldier Experiment (AMRDEC, TARDEC)
- Spin Out 1 Integration Events (SO1-IEs)
- Earth, Wind and Fire (Ft. Sill, ARDEC)
- FCS ACE Service (ARL, TARDEC, ARDEC)

- **Persistent network**
- **Facilitates sharing of capabilities**
- **Collaborative use of RDECOM and Army resources**
- **Work requirements as integrated systems of systems**

FY08 MATREX Projects (1/2)

Activity	Description
Network Centric Warfare	M&S supporting entity-level analysis/experimentation capabilities of Battle Command
Distributed Virtual Laboratory (DVL)	RDECOM network supporting distributed simulation, simulation events, interoperability with ATEC, TRADOC, FCS LSI
Event Management	Sim Init, DCRA, Analysis, Data, SE, tools, and processes, cross-command collaborative development, 3CE Sim Init IPT lead, Data Management IPT participant
VV&A	Independent assessment and update of MATREX/RDECOM M&S products
RDECOM	MATREX tools, processes, integrated RDEC federates, SE processes, IPT support, DVL, integrated PEO/PM support
3CE	3CE Core Planning, collaborative requirements development, host or support IPTs, SO1 Support for HLA and MATREX FOM
FCS LSI	Integrate Armaments Server, Missile Server, MATREX HLA, FOM, tools, collaborative architecture and environment development
ATEC OTC	Transition JOSIE+1 USAOTC federation from DIS to MATREX HLA using ProtoCore, training, support, develop L-VC interoperability

FY08 MATREX Projects (2/2)

Activity	Description
TRADOC BLCSE (MMBL)	Supporting installation of MATREX HLA, tools (inc SA dissemination), and federates at MMBL, proof of process prior to engaging other battle labs
C4ISR On-The-Move Testbed	Phase 1: Transition to MATREX HLA and tools; Phase 2: Support MATREX community with MATREX/Testbed interoperability
PEO GCS (PM Stryker)	Phase 1: MATREX RTI, FOM, tools; Phase 2: MATREX/RDECOM/USAOTC interoperation supporting embedded training with M&S wrap-around
PEO Soldier	Supporting transition to MATREX HLA and tools
OneSAF	Dross-community collaborative SAF capability development, integration into MATREX environment
CB Sim Suite	Integrate the CB Sim Suite with entity-level MATREX architecture and environment to support high-resolution CBRN analysis (SO-2 rqt and more)
Sensor Fusion	Level 1 sensor fusion algorithm integrated with Organic Communication Service in MATREX environment
Human Performance	Model the decision-making of individual combatant for Battle Command
Comms and Network Effects	Integrate SNT CES, other CES, requirements from FCS LSI and 3CE
Event Participation	Jamus: Transition AMRDEC M&S to MATREX HLA, tools, federates, support and training; C4ISR OYM: same; others in planning